

Measurement of the ^{12}C Thermal Neutron Radiative Cross Section

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The ^{12}C thermal neutron radiative cross section is important for determining the thermal properties of graphite neutron moderators. We have derived total thermal neutron radiative cross sections for many isotopes from our evaluation of gamma-ray cross sections for PGAA analysis. In most cases the agreement with the adopted values of Mughabghab and the experimentally deduced values is fairly good, especially for light nuclides, and the precision has been improved in many cases. One notable discrepancy is the cross section for ^{12}C where the new value of 3.89 ± 0.06 mb exceeds the adopted value of 3.53 ± 0.07 mb by 10 ± 3 %. A summary of the eleven measurements considered in deriving the adopted value is given in Table I. Four measurements agree with the new value within one standard deviation and five measurements disagree by more than two standard deviations.

In view of the importance of the carbon cross section, new experiments were performed at Budapest on four different compounds containing carbon with a well defined stoichiometry to test the accuracy of the new value. These measurements yielded a cross section of 3.87 ± 0.03 mb, in excellent agreement with the earlier value. Other recent values deduced from JAERI k_0 -factors [20, 21] are 3.63 ± 0.13 mb for their cold

neutron guide and 4.01 ± 0.15 mb for their thermal neutron guide. All of the measurements discussed in Table I were performed with external comparator standards and may be susceptible to error due to neutron scattering, so we recommend that the new internally calibrated value should be adopted in the future. The implications of this large increase in the ^{12}C thermal neutron radiative cross sections to graphite reactor designs should be investigated.

Footnotes and References

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Measurement Method	^{12}C Cross Section (millibarns)	Reference
Diffusion length	3.44 ± 0.8	Hendrie [9]
Mass spectrometry	3.30 ± 0.15	Henning [10]
Pile oscillator	3.5 ± 0.3	Muehlhause [11]
Pile oscillator	3.65 ± 0.15	Ref. [12]
Pile oscillator	3.85 ± 0.15	Koechlin [13]
Pulsed neutrons	3.72 ± 0.15	Sagot [14]
Pulsed neutrons	3.83 ± 0.06	Starr [15]
Reactivity	3.57 ± 0.03	Nichols [16]
PGAA	3.8 ± 0.4	Journey [17]
PGAA	3.53 ± 0.07	Journey [18]
PGAA	3.50 ± 0.16	Prestwich [19]
Adopted value	3.53 ± 0.07 mb	Mughabghab [1]

Table I. Comparison of thermal neutron-capture cross-section measurements on ^{12}C with the value adopted by Mughabghab et al [1] and the results of this evaluation. Our new value is 3.87 ± 0.03 mb.